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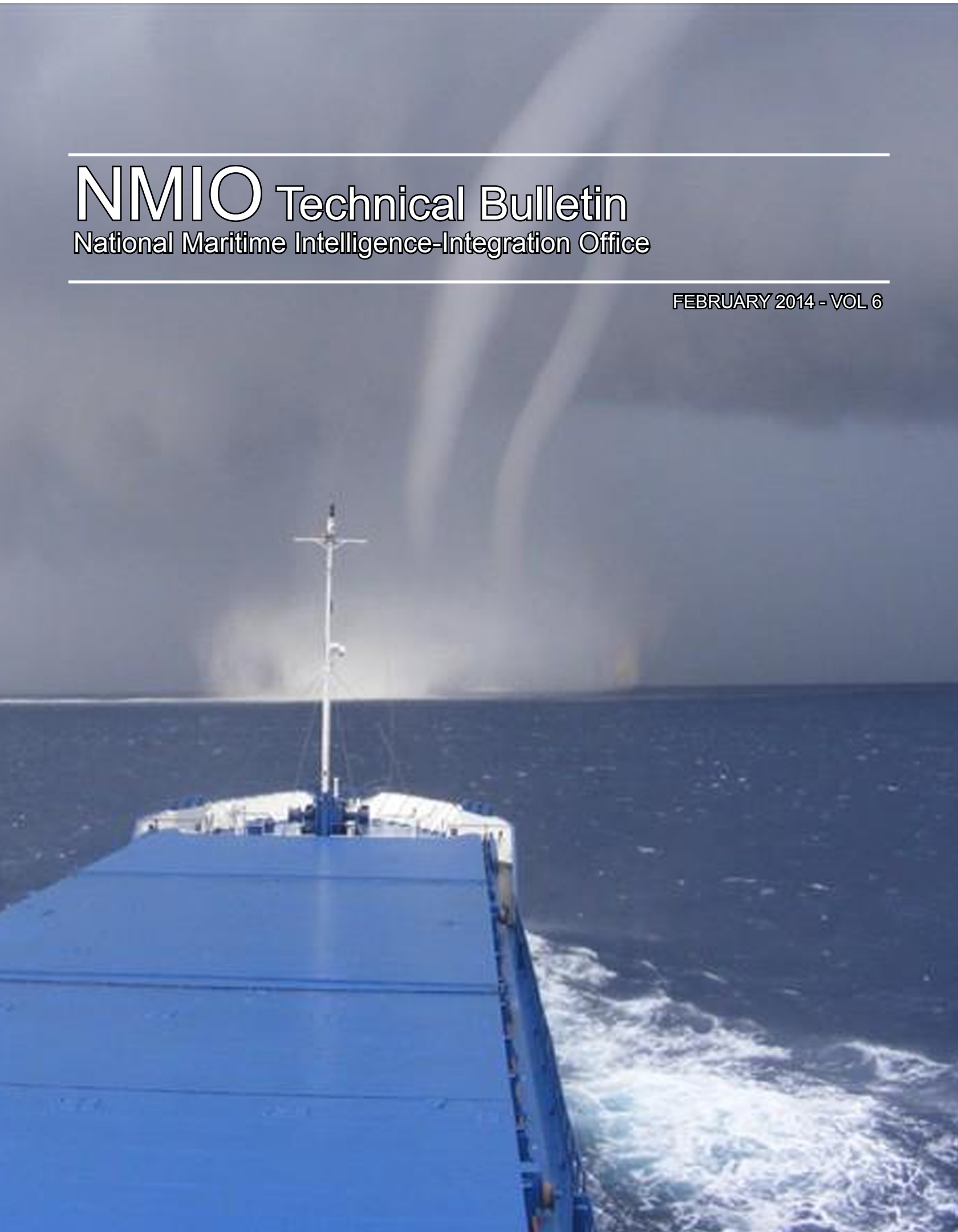

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GINA Network-Centric Assemble-to-Description Architecture

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Abstract: Global Information Network Architecture (GINA) is an analytic modeling environment that represents the entire information environment as super metadata and captures the interoperation between the user and the system as data. GINA allows the definition of a user-interaction model to be easily changed over time, conforms to new usage patterns as additional facilities are brought online, and allows interoperability between any end-product systems.

GINA is the new model for managing the complex interoperability demands of large system-of-system implementations. In 2012, the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC), the Army Training and Doctrine Command, and researchers from Big Kahuna Technologies demonstrated a semantically-rigorous modeling and implementation capability that dramatically improved the means to achieve interoperability. The goal was to provide a form of GINA to the 129th Rescue Wing of the California Air National Guard to link and integrate a wide range of sensors and platforms not designed to work together. The result was the Dragon Pulse Information Management System (DPIMS) – a multi-sensor-type array for situational awareness.

DPIMS is a semantic modeling environment in which the various meanings in language or logic are transmuted into assemblies that accurately implement a model in which all systems, sensors, etc., are interoperating transparently. While DPIMS enables the aggregated information to be treated as a single application or information store, the data can also be interoperated with and understood by disparate computational structures. DPIMS makes it possible for very different (and unlikely) platforms to communicate, aggregate, format, interoperate, and visualize data that is meaningful to all platforms.

Figure 1 illustrates the types of data that can be fused and rendered interoperable across platforms. The concentric range rings and a range gate may be applied to any given entity; a proximity rule can then be implemented. In this case, the range ring is assigned the color red. Different entities may be visually discerned by assigning different colors to their attributes. Command and control now gains an instant picture of the different entities on the map. Figure 2 illustrates the ability to show sensor alarms in various detail and sensor-specific configurations.

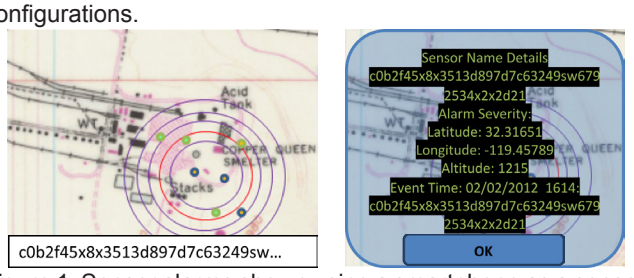

Figure 1. Sensor alarms shown using a smartphone as a sensor.

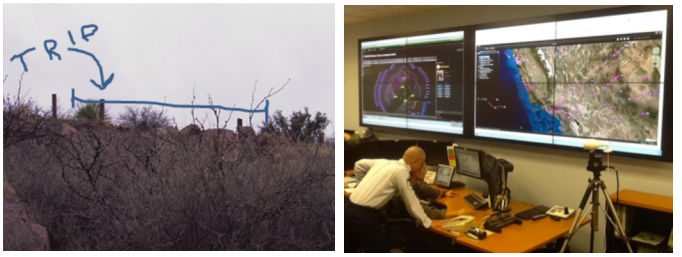

Figure 2. Edits to imagery made using third-party applications on smartphones (photos, 129th Rescue Wing).

Interoperability in the maritime domain poses problems beyond those of simple network operations involving different sensor systems, such as those that would be found on ships of different navies (Figure 3). Depending on the level of coupling and cohesion required to connect the intended network of systems (i.e., cooperation and interoperability), GINA's ontological structures support information sharing, reuse, and stability through product inheritance to provide and maintain interoperability.

Figure 3. USS Ronald Reagan and the Brazilian Navy aircraft carrier BNS Sao Paolo.

GINA interoperability is more than systems or their elements communicating and working with each other. Interoperability is the action of completeness (having all the appropriate and necessary parts and forms) and incompleteness (establishing the limitations) when two or more systems or components interact and exchange energy, matter, material wealth (e.g., money), and information (EMMI). Interoperability is achieved when two or more systems interact and exchange EMMI in a manner necessary and sufficient for the individual systems to retain their autonomous behaviors and enact meta-level system-of-systems functionalities.

GINA is the result of successfully constructing an architecture for assembling systems-of-systems using an extended modeling vocabulary for completely describing them and a component-based object model that forms the raw material

for implementation. GINA defines the relationship between the user and the model, rather than the user and the computing platform, and performs a more refined information access and control structure than is possible using traditional modeling and/or programming techniques. Using standard communications protocols and serial interfaces, GINA works with interoperability protocols such as Web Services and operates with syntaxes such as forms of XML.

GINA was designed as a set of services on the network, rather than as an application on any particular computing platform. The result is that the implementation is truly "network-centric". GINA takes traditional applications to the "cloud" or creates "cloud-based" alternatives to existing systems. GINA's network-centric, assemble-to-description architecture is scalable, extensible, and expandable with minimal effort.

Figures 4 and 5 illustrate the traditional means to achieve some level of interoperability and the GINA means to achieve full interoperability. The simplicity of Service Oriented Architecture (SOA) is carried out by a "star"-type implementation. In contrast, GINA's simplicity is through its interoperability model; GINA connects all nodes to all nodes. The cost and schedule impacts for traditional means are prohibitively expensive and time-consuming. In comparison, GINA required less than 16 labor hours to completely implement a fully interoperable, integrated operational capability of multiple sensor systems at Camp Roberts near San Luis Obispo in central California in support of search and rescue missions.

GINA development began as a Cooperative Research and Development Agreement at the Naval Postgraduate School in FY 2004. GINA was DITSCAP-Certified Class 3 (Network-Aware Business Data Management System) in 2005, and various U.S. government customers began using GINA in 2006. GINA is the next technological step beyond the N-Tier approach; GINA supersedes N-Tier as the most advanced approach for integration and interoperability.

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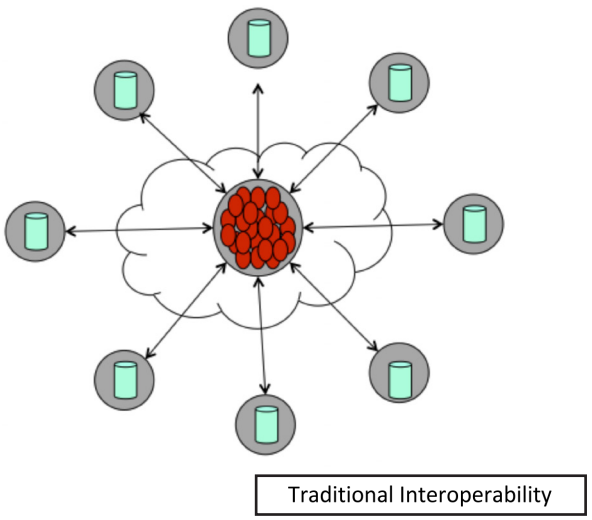

Figure 4. "Simple" interoperability of Service Oriented Architecture shown as geometric in nature.

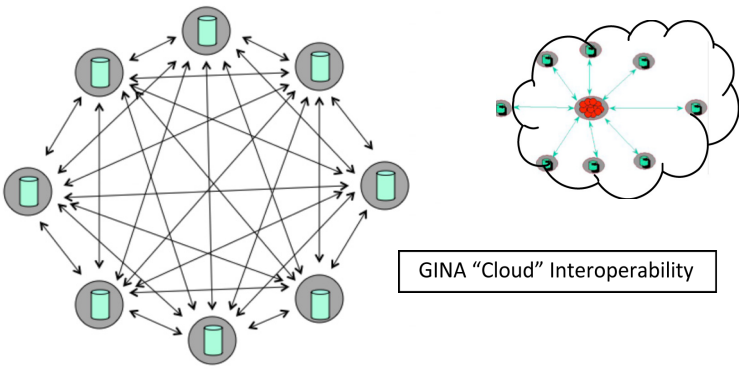

Figure 5. GINA interoperability allows for complex integrations with "simple" interoperability.